COPING WITH COLD

Frank Lane [illegible]re Agency

Cameron McNeish/Mountain Camera

- WARNING NETWORKS
- WATERPROOFS
- SNOW BUSINESS

MACHINES AND MATERIALS come to the rescue when the weather gets too hot, too wet or too cold. A great deal of effort goes into dealing with the effects of cold weather in particular, as snow and ice can severely disrupt both travel and communications.

Keeping wintry roads clear is a sophisticated and well-organized business involving salting trucks, snow ploughs, snow blowers and, in some areas, computer-controlled warning networks that include electronic roadside monitoring stations.

Snow busters

In areas that have more than their fair share of snow, a salt and grit mixture is used to keep the roads clear. Salted water freezes at a considerably lower temperature than salt-free water, so salting snow makes it melt and drain away. If the temperature were to drop dramatically after salting, however, the melted snow would turn into sheet ice. Using grit in conjunction with the salt prevents this from happening.

Gritting machines can be mounted on lorries or towed behind vehicles, and fleets of these are used to deliver a measured dose of salt and grit.

Trucks can also be fitted with snow ploughs for road clearing and farmers are sometimes called on to mount snow ploughs on tractors to deal with snow drifts of up to two metres. Snow blowers with turbocharged diesel engines can be mounted on mechnanical diggers to cope with snowdrifts up to five metres deep.

In some weather-monitoring networks there are roadside sensors that can measure air temperature, road temperature, soil temperature,

***Prolonged exposure** to wet and cold can cause hypothermia. A waterproof sleeping-bag keeps the body warm and dry. A mix of salt and grit helps to keep roads open (top). As salt melts the snow, grit prevents it from re-freezing.*

wind speed and direction, as well as the salinity of water on the road. The sensors are linked by telephone lines to a computer system. The computer system receives information from a central weather centre and has a sophisticated programme of its own to assess the need for salting all, or just certain, key roads that are at risk from ice or snow.

Keeping snug

In wintry weather, clothing made with thick insulating materials is ideal. Perhaps the best of these is down, particularly that of the Eider duck. If the garment is designed properly so that there are no thin patches, then down – worn with several other layers of clothing – can keep out the worst cold, including that found at the north and south poles. Any other fabric or material that traps small pockets of heat close to the body will make a good insulator against the cold.

Another heat-retaining material is the thin, shiny, metallic, reinforced fabric popularly known as the 'space blanket'. This does not stop air from escaping, but retains radiated heat by reflecting it back.

Modern fabrics are designed to keep rain out and let perspiration out too, cutting down on the 'wet inside' feeling from non-permeable coverings such as rubber and polyvinyl chloride (PVC). Waterproof fabrics such as Gore-tex are made up of an outer fabric above a lining material over a membrane that has nearly 10 billion tiny holes, or pores, in every 6.5 sq cm of material. Each pore is about 20,000 times smaller than a raindrop, but 700 times larger than a water vapour molecule produced by perspiration. Thus, water produced within can get out – but rain or melted snow cannot get in.

***The armed forces** are kitted out to cope with weather extremes. Uniforms, made of Gore-tex, allow for sufficient ventilation to deal with perspiration, but prevent any rain seeping through to the wearer's skin.*

E. Nevill/TRH

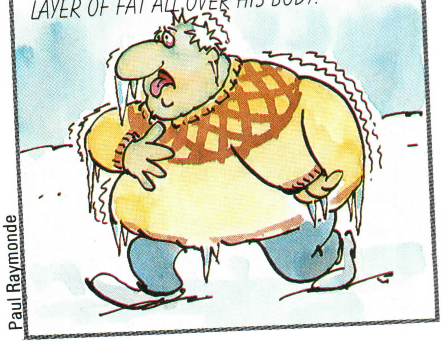
***Snow blowing** machines are used to clear minor roads in outlying areas which have insufficient access for the larger snowploughs. These machines are part of a specialized fleet of equipment.*

John Cleare/Mountain Camera

Just amazing!

FAT WONDER

A 125 KG ICELANDER SPENT SIX HOURS IN ICY WATER, THEN WALKED FOR THREE HOURS OVER A FROZEN LAVA FIELD WEARING ONLY JEANS, A SHIRT AND A SWEATER. HE WAS SAVED BY THE 14 MM LAYER OF FAT ALL OVER HIS BODY.



Paul Raymonde

HYPOTHERMIA – THE VITAL SIGNS

Long immersion in cold water, wearing wet clothes at high altitudes and general exposure to cold in an unheated or badly heated house for a long time can all induce hypothermia.

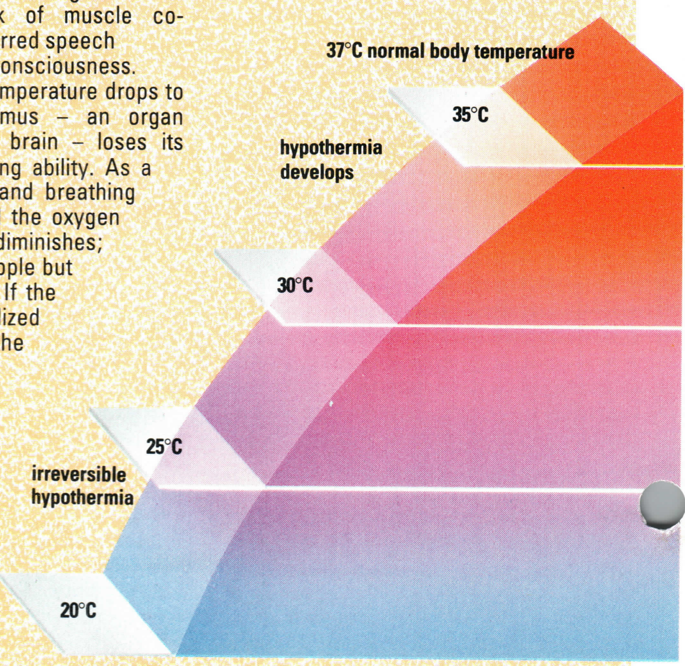
When the body temperature starts to drop below the normal 37°C the victim progressively:

- complains of feeling miserably cold
- feels abnormally cold to the touch
- starts to shiver uncontrollably
- stops shivering and begins to experience a lack of muscle co-ordination and slurred speech
- eventually loses consciousness.

When the body temperature drops to 30°C, the hypothalmus – an organ situated below the brain – loses its temperature-regulating ability. As a result, cell activity and breathing rate slow down and the oxygen supply to the brain diminishes; the heart muscles ripple but do not pump blood. If the victim is not hospitalized at this point, he or she will undoubtedly die.

When dealing with a conscious hypothermia victim:

- replace wet clothing with dry garments
- wrap them in a blanket, but do not cover their face
- do not rub or massage them
- do not give them alcohol
- never place their hands or arms in direct contact with their body.



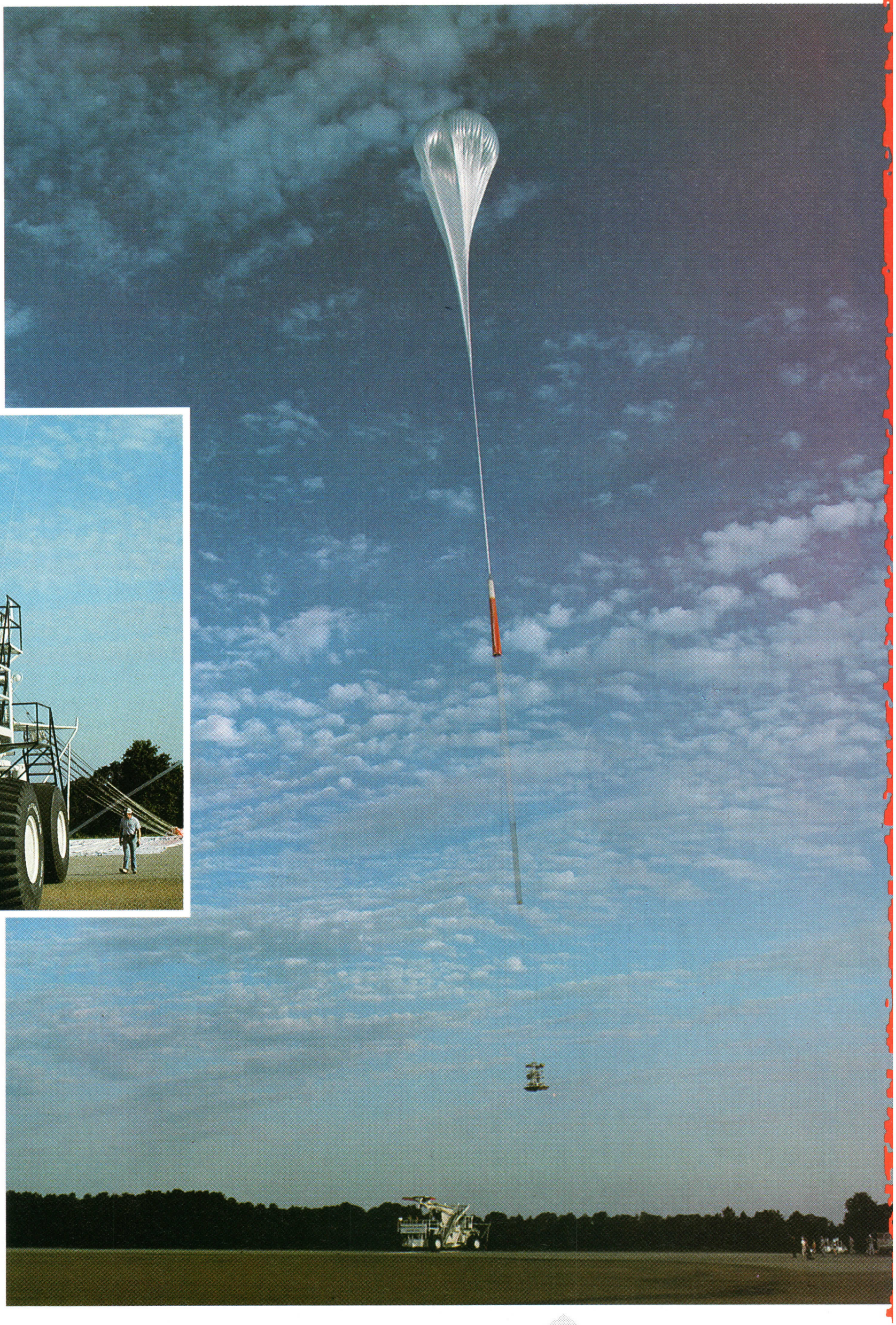
Janos Marffy

JET STREAM WINDS

WEATHER BUOYS

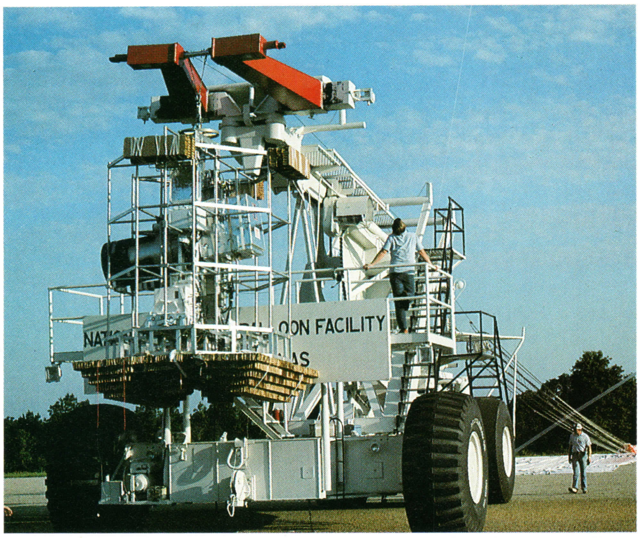
NUMBER CRUNCHERS

FORECASTING



POWERFUL NEW TOOLS available to meteorologists enable them to produce more and more accurate predictions. Reliable forecasts can now be made for 24 hours ahead, and work is underway to refine the long range forecasts that look up to a month ahead.

All this effort is not just to make sure that you choose a sunny day for your picnic. It is a matter of life, death, or large sums of money for all sorts of people. These include not only fishermen and sea captains wondering whether or not to put to



Telegraph Colour Library

sea, but also airline pilots and farmers who want a fine, settled period of weather to sow and harvest their crops. Even ice cream makers vary the number of cornets they make according to the weather forecast.

Before meteorologists can make a forecast, they need to have an extremely accurate picture of what the weather is doing over as large an area as possible. So weather observations are collected from:

- ground stations
- stratospheric weather balloons
- a countrywide radar network
- polar-orbiting and geostationary satellites
- oil rigs and automatic buoys
- civilian aircraft and ships
- special weather flights.

Synoptic observations

All levels of the atmosphere must be observed because a shift in the upper atmosphere winds of 2,000 km can trigger a radical change in the weather. That upper atmosphere change might, in turn, be a reaction to a weather event in the opposite hemisphere two or three days previously. So weather information must be collected all round the world to give a complete picture.

The accuracy and type of observations made are crucial, as well as the time when they are made. In order to get a snapshot of what is going on at any one instant, observations are made synoptically. This means that they are taken at the same time worldwide, with the main observations coming at 00.00, 06.00, 12.00 and 18.00 Co-ordinated Universal Time (UTC) or, as it is otherwise known, Greenwich Mean Time (GMT). The data are then sent via communications satellite, land line or radio to one or all of the world's meteorological centres.

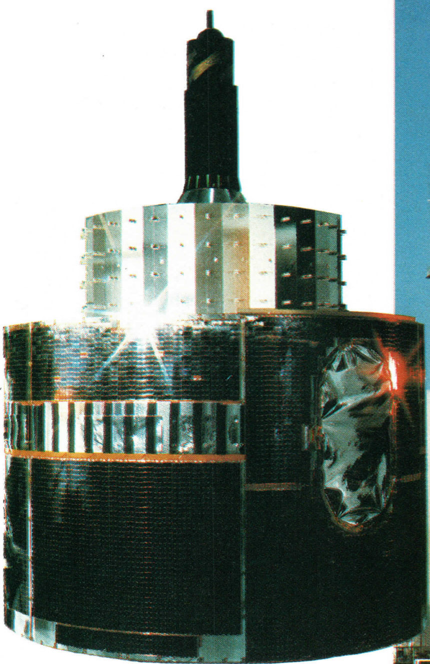
__Radiosonde balloons__ are launched from airfields using a large trailer (inset). The balloon carries instruments and a radio that parachute back to Earth.

At a ground station, a trained observer measures wind speed and

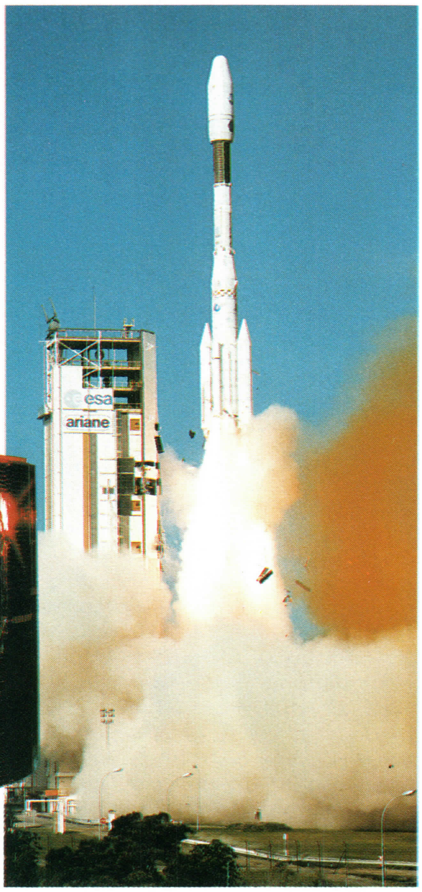
Limier/Jerrican

***Most ground stations** have a louvred enclosure that shelters the instruments without cutting them off from the weather phenomena that they measure.*

***Meteosat geostationary** weather satellites (below) are launched on Ariane rockets from Kourou in French Guiana. Each one covers a fifth of the globe, so five are constantly on station to provide worldwide coverage.*



ESA



direction, as well as visibility, atmospheric pressure, air temperature and dew point temperature. (See Elements in Action, Planet Earth, pages 29–32 for information on dew point.) The observer also reports cloud types and amounts, and general weather conditions. He or she also measures the amount of rainfall, hours of sunshine and temperature maximums and minimums on a daily basis.

Despite their name, ground stations can also be on water – around the world there are thousands of stations all making identical weather reports. For example, in the British Isles alone, there are about 65 weather stations that report back every hour of the day and night to the British Meteorological Office Headquarters at Bracknell, Berkshire. Another 35 or so weather stations report back every hour during daylight.

Weather ships

Weather forecasters used to rely on weather ships for mid-ocean observations, which are very important because this is where many weather systems are born. These are now being replaced by automatic buoys. The buoys transmit weather data back to a data collection station on land. There is also a moving network of about 7,000 merchant ships that carry meteorological apparatus and report back. Of these ships, about 2,500 send their reports to Bracknell.

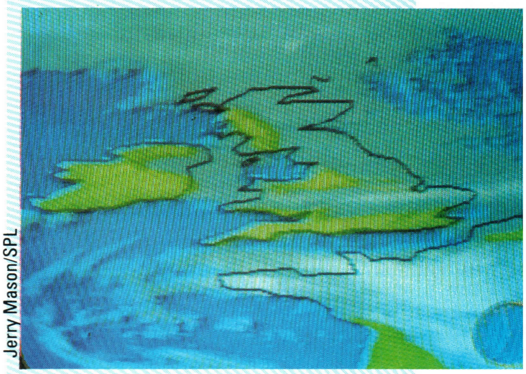
Useful as all the observations taken at surface level are, they must be complemented by measurements of weather conditions higher up in the atmosphere. This is where balloons (called radiosondes) come in. Around the world there is a network of stations where helium- or hydrogen-filled instrument carrying balloons are released every six or 12 hours.

The balloons rise 15 km in the air before they burst. The instruments measure pressure, temperature and humidity at frequent intervals during the ascent, and transmit the data to a ground station or satellite, which then relays it to Earth.

The wind speed and direction are determined by radar tracking of the balloon as it climbs. From launch to maximum height takes about an hour. There are not as many balloon-launching stations as the meteorologists would like – they are expensive to maintain – especially in the oceans.

An alternative scheme called the Automated Shipboard Aerological System (ASAP) is already being employed. Merchants ships launch balloons that transmit their data direct to a satellite that relays it to a ground station. The balloon's movements after launch and, therefore, the wind direction and speed are tracked using a satellite navigation system.

TV WEATHER MAPS

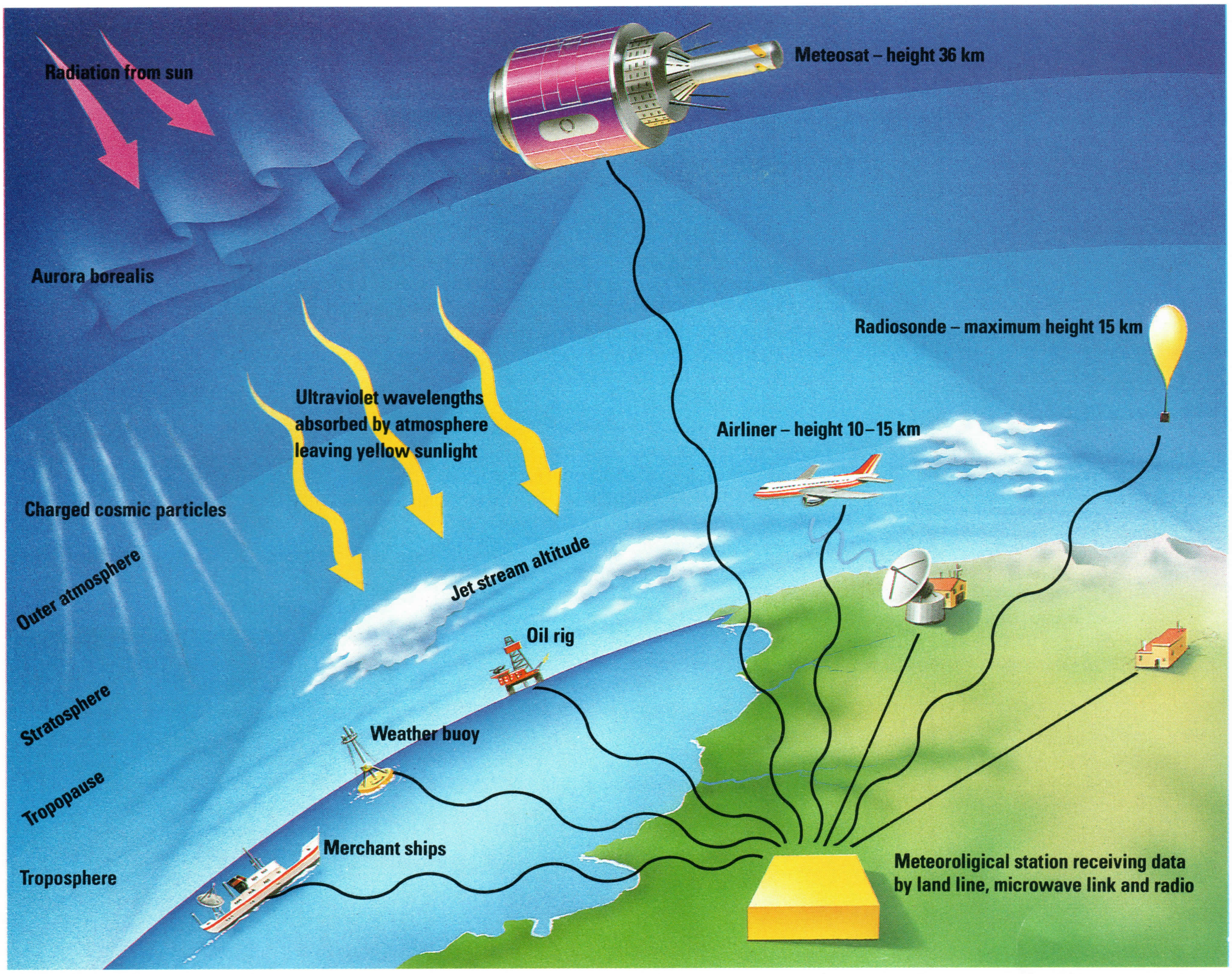


Jerry Mason/SPL

Satellite pictures can be used, along with radar observations, to make a picture of the weather systems over a large area. The two forms of data are merged in a computer that presents the results on screen as they happen – 'in real time'. These pictures are often used to illustrate the weather forecast on TV. They are also used by the TV weathermen themselves to up-date their forecasts as necessary. Satellite pictures of weather systems are very easy to interpret. A knot of clouds means a storm, and a careful look often reveals a cold front.

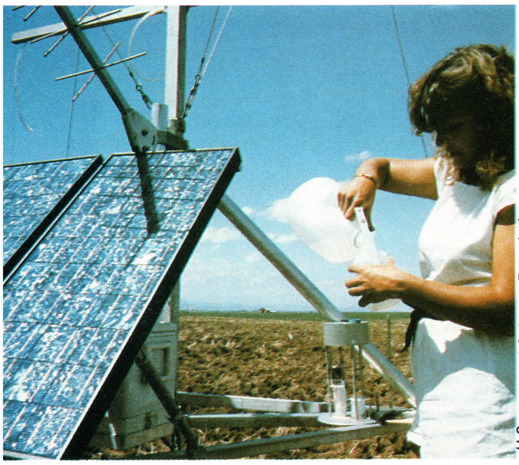
Aircraft

Jet airliners fly at a height of 10-13 km, which is one of the most important levels of the atmosphere.



Chris Lyon

The troposphere is the scene of most of our weather. Data is collected by satellite, ground stations, buoys, oil rigs and balloons to be analyzed by computer.



U.S./National Science Foundation

***Photovoltaic cell panels,** which convert sunlight into energy, are used to power some ground stations. They even work in northern latitudes.*

This is where the jet streams blow from west to east at speeds up to 300 km/h. Changes in a jet stream trigger major weather changes. As an example, it was a very fast jet stream that caused the 1987 hurricane-force winds in southern Britain and western France. To observe these changes, many aircraft are now being fitted with automatic instrument packages that collect and report back temperature, wind speed and direction, wind turbulence and the plane's position and height.

The data are transmitted automatically every hour to a weather centre via communications satellites. The system, called Aircraft to Satellite Data Relay (ASDAR), is providing weather forecasters with much valuable information about the upper atmosphere. The system is also able to make readings as a plane climbs or descends, filling out the picture sent back by radiosounds.

Satellites

Satellites have made a dramatic impact on weather forecasting becuase they can send back large enough pictures of cloud formations to show complete weather systems. A sequence of pictures taken at different times enables forecasters to see how weather systems are moving and developing.

Currently, two sorts of meteorological satellite are used. Geostationary satellites, such as the Meteosat series, cover about a fifth of the world's surface on a permanent basis. Polar orbiting satellites, such as the Tiros series, send back data from narrow strips of land from north pole to south pole.

***Sunshine recorders** focus the rays of the Sun on to a strip of paper – the length of the burn indicates the hours of sunshine.*

Casella

Satellites carry radiometers to measure electromagnetic radiation. This radiation comprises visible light, infra-red (heat) radiation and microwave radiation. They also use infra-red techniques to make assessments of temperature and humidity at various levels in the atmosphere.

Satellites are particularly important to weather forecasters because they provide information from areas where balloon coverage is poor. The information gathered by satellite is relayed back to ground receiving stations for analysis.

Accurate forecasts

Some countries maintain a network of weather radar stations. These give an accurate – and instantaneous – picture of how belts of rain (associated with warm and cold fronts) are moving across country. With this information, forecasters can compile accurate short-range forecasts. Such forecasts have a very practical purpose. They can, for example, influence whether or not a local council will salt the roads to prevent ice forming.

A worldwide network of meteorological communications centres are linked by very fast telecommunications circuits so they can exchange these vast amounts of coded data quickly. There is so much data to process that it can only be done by the most powerful computers.

Weather forecasting systems are based on computer programs that are mathematical 'models' of the way the weather works. These use the synoptic readings taken at 00.00 UTC and 12.00 UTC to determine the current situation. The model is then used to forecast the weather situation as it will be minutes, hours and days ahead using equations developed by expert meteorologists.

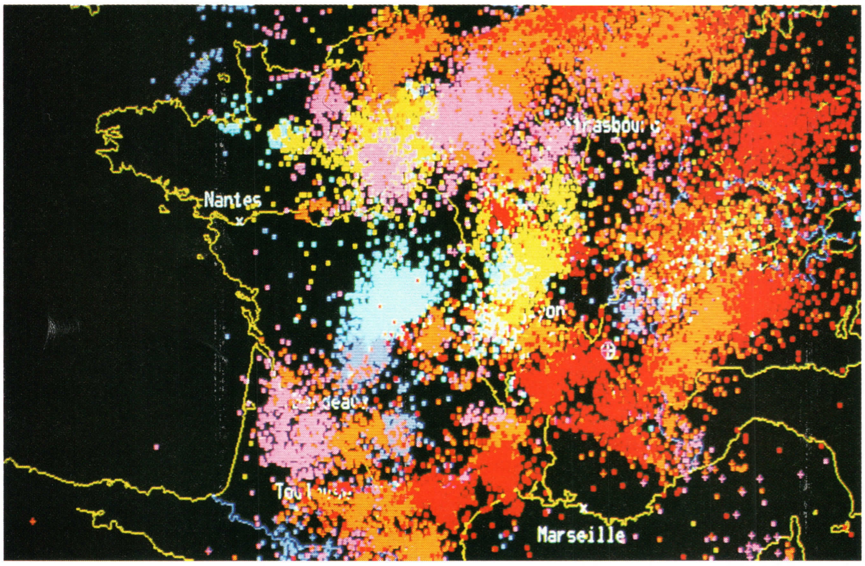
Computer charts

One mathematical model running on the COSMOS computing system works out the weather for all the points on an imaginary grid, with points spaced about 150 km apart at ground level. It also works out the weather for 15 heights in the atmosphere above each grid point using radiosonde and aircraft data.

Meteorologists add any other information they think appropriate from other sources such as satellite observations and aircraft readings. The information is then presented on charts drawn by the computer. These charts show the atmospheric pressure at different levels of the atmosphere, and are worked out up to six days ahead.

At the end of the computer run, charts and forecasts are examined by a human meteorologist who interprets the information in the light of experience. He or she also takes local geographical features such as mountain ranges and low lying land into account because these can make the difference between low cloud and rain.

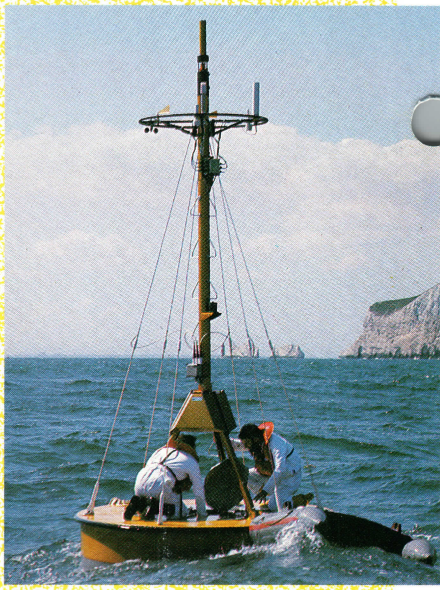
After all this mighty number crunching and analysis, the forecasts and charts are made available to TV and radio stations, airports, public services, police, local authorities, motoring organizations and anyone else who needs them for commercial purposes and is therefore prepared to pay for them. For some users, specialized forecasts are prepared and tailored to their needs.



Ivaldi/Jerrican

***Satellite data** relayed back to Earth is recorded on magnetic tape. Computers process the data and draw up maps showing features that meteorologists wish to study. The dots on this map represent lightning strikes and give a picture of low-altitude electrical activity.*

ELECTRONIC BUOYS


Marex

Weather buoys were developed for studying both weather and sea conditions in the North Sea during the exploration stage of North Sea oil. The basic buoy – a steel drum about 2 metres across and 1 metre deep – is divided into waterproof compartments containing the micro-computer, the radio transmitter and the batteries.

As well as standard weather observations, weather buoys can be used to measure wave height and currents within the sea itself. The top of the drum carries a mast about 5 metres high, which supports the main meteorological sensors. The sensors for sea conditions are attached to the mooring cable. Weather buoys can transmit data back to a computerized shore station for up to one year before the batteries and transmitters need servicing. Buoys are normally anchored in shallow water, close to the coast, but deep water versions are also used.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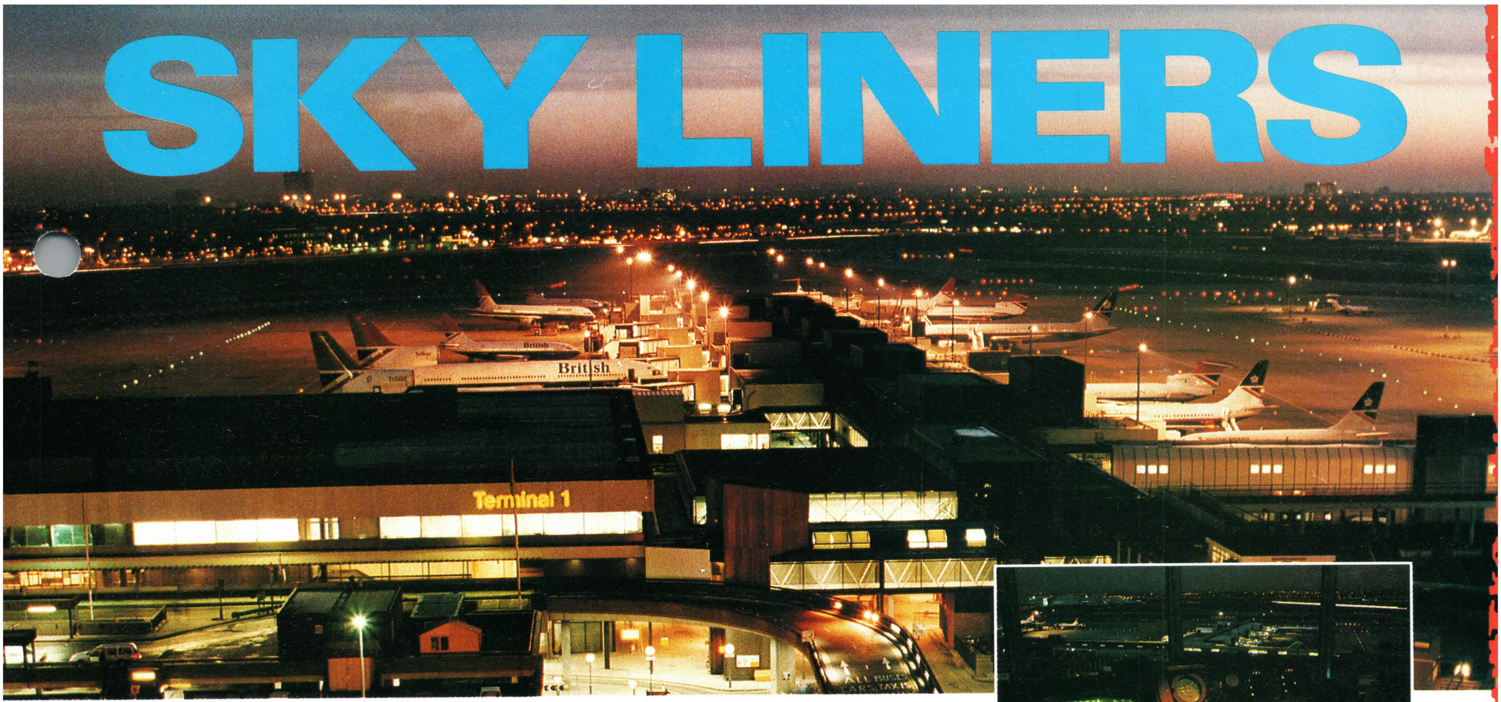
***COSMOS**, the computer-based forecasting system, processes 3½ million numbers every time it draws a map of the atmosphere. As each number involves several calculations, the computing capacity required is phenomenal.*

SKY LINERS



AIR TRAFFIC

LANDING SYSTEMS

SPACE PLANES

THE WORLD'S BUSIEST airports each handle over 1,000 aircraft take-offs and landings per day at the height of the holiday season. This can mean that over 100,000 passengers have to be guided safely, quickly and without annoyance through the airport during the course of a day.

An outbound aircraft comes under the control tower's surveillance even before it has started its engines. Permission to start engines is requested by radio from the Ground Movement Planner, who can observe the movements of all aircraft and vehicles at the airport from the Visual Control Room in the tower. He is assisted by ground movement radar, which displays a screen image so detailed that he can even see abandoned rubbish lying around the airfield.

Permission to take off comes from a different authority – Airfield Control, also located in the Visual Control Room. Once in the air, the plane is guided towards the airway, or air lane, along which it will fly. As the plane leaves the terminal control area, control is passed on yet again to the neighbouring region's Air Traffic Control.

One way traffic

The airways are like motorways in the sky, 16 km wide and extending from about 1.5 km to 7.5 km high. Streams of planes fly along each airway in one direction only. Aircraft at the same height are separated by at least 9 km horizontally. If they are separated by less than this horizontally, they must be at least 300 metres apart vertically.

At peak times, a plane wanting to land may have to wait in the stack – a series of circling flight paths near a radio beacon some kilometres from the airfield. The levels of the stack are spaced at least 305 metres apart. The aircraft descends in the stack until it can eventually come in to land. When it is lined up to land, about 10 km from touchdown, control is passed to the Air Arrivals Controller in the Visual Control Room. During its descent, the aircraft is kept on course by the instrument landing system (ILS), which uses two radio beams. The localizer beam extends along the centre line of the runway – to a distance of 40 km in the case of London Heathrow. The glideslope beam helps the pilot bring the plane down at the correct angle. When the weather is clear, he can also see carefully angled lights beside the runway that change appearance if his angle of approach is incorrect.

Heathrow Visions

***The Visual Control Room** (inset above) has ground movement radar (large screen) and a distance-from-touchdown indicator (small screen) to aid safe landings at Heathrow (top).*

Heathrow Visions Picture Library

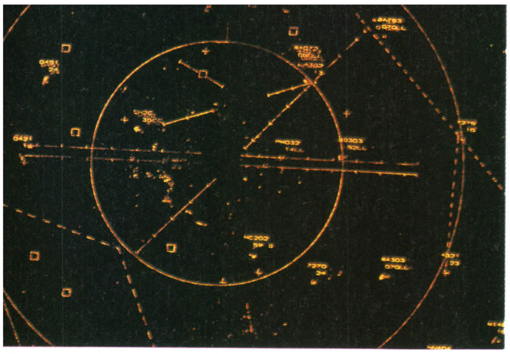
***Good communications** with the air traffic controllers are essential for safety in busy airspace around London's Heathrow. Direct radio communications allow contact with aircraft, emergency services and airport vehicles.*

Controllers can speak to aircraft and vehicles on different radio frequencies at the same time.

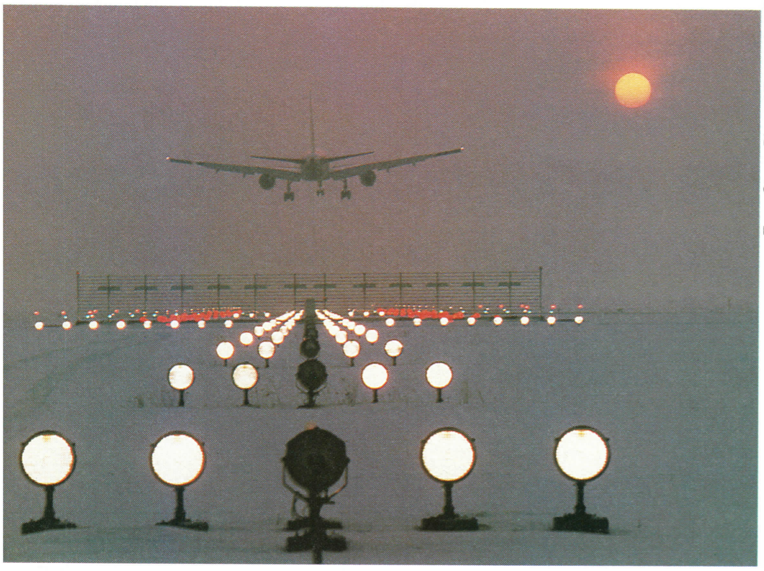
Radar displays

The skies are scanned by two main types of radar. Primary radar sends out ultra-high-frequency radio pulses that bounce off aircraft. The reflected radar signal is picked up by the radar antenna. The direction of this echo and its delay in returning reveal the position of the aircraft, which is shown as a 'blip' on the radar's display screen.

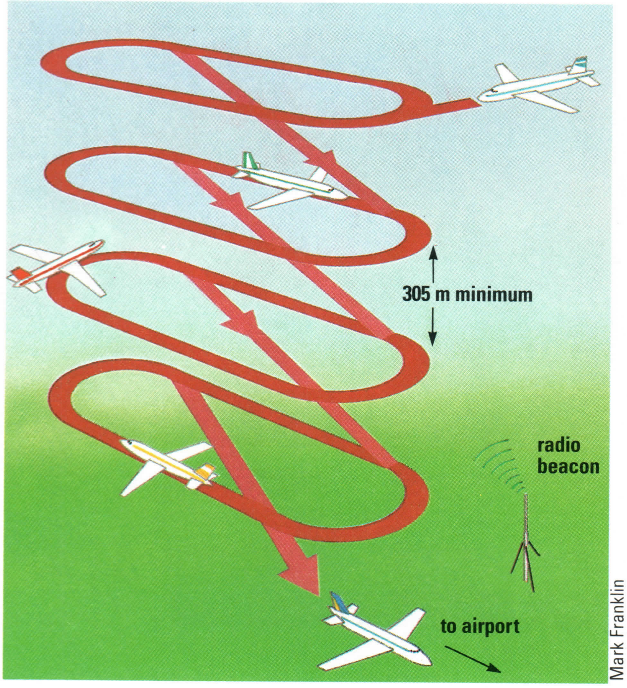
Secondary radar also sweeps the sky with a radio beam that triggers a device on the aircraft called a transponder. This instantly sends out a radio pulse with coded in-



The radar display *used by air traffic controllers shows aircraft positions and movements. Planes transmit identification signals; a computer converts these into callsigns that are displayed on screen to identify each blip.*



Tony Stone Photo Library, London



Mark Franklin

Lights and radio beams *help the pilot approach the runway from the correct direction and at the right angle as he brings the aircraft in to land at major airports.*

Aircraft wait *in a stack in an area marked by a radio beacon. When a runway becomes free, the bottom plane lands and the rest move down the stack.*

Heathrow Visions Picture Library

formation. The radar aerial picks up this signal, and the blip on the display is labelled with the aircraft's callsign. If there is some kind of emergency on board, such as a hijack, the pilot can press a button so that a warning message to that effect is also displayed on the Air Traffic Control radar.

Passenger flow

Imagine the problem of dealing with the passengers from ten jumbo jets that arrive at an air terminal in a half-hour period. That's not an unusual load – yet it can mean that about 4,000 people have to be reunited with their baggage and processed smoothly through customs formalities and immigration checks.

There must also be room at the airport for the friends and relatives who've come to greet passengers or see them off. New airport handling facilities, like those operating at New York's Kennedy International Airport, aim at processing an amazing 6,000 passengers an hour.

Airport design

Another problem faced by all airports is how to spare passengers long walks to or from the plane. A parked jumbo jet takes up a bay about 90 metres wide. If a dozen of these planes were parked side by side, passengers would have to walk over one kilometre to get to the furthest one.

Moving walkways

Airports are carefully designed to reduce this problem. In many cases, aircraft berths are arranged along piers that stick out like spokes from a hub that contains a departure lounge. Even so, moving walkways are standard in many airports now. Other 'people movers' include slow, constantly moving 'trains' that travellers step on to and off again. Another solution is to park aircraft out on the apron, well away from buildings, and take the passengers out to them in comfortable mobile lounges.

The movement of baggage is more highly automated. At the check-in counter, the baggage is weighed and tagged so that it will find its way on to the same plane as its owners, and will be reunited with them at their destination. It is carried on conveyor belts to a baggage loading point where it is packed into containers that can be loaded straight on to the aircraft.

Electronic scanning

In advanced modern systems, baggage tags are electronically scanned and the bags are automatically sorted and despatched to the right destination. In some airports, the bags are moved by robot tractors, which are called DCVs (destination-coded vehicles).

Heathrow Visions Picture Library

London's Heathrow *is the world's busiest international airport, with over 300,000 landings or take-offs each year, involving over 30 million passengers and some 600,000 tonnes of goods.*